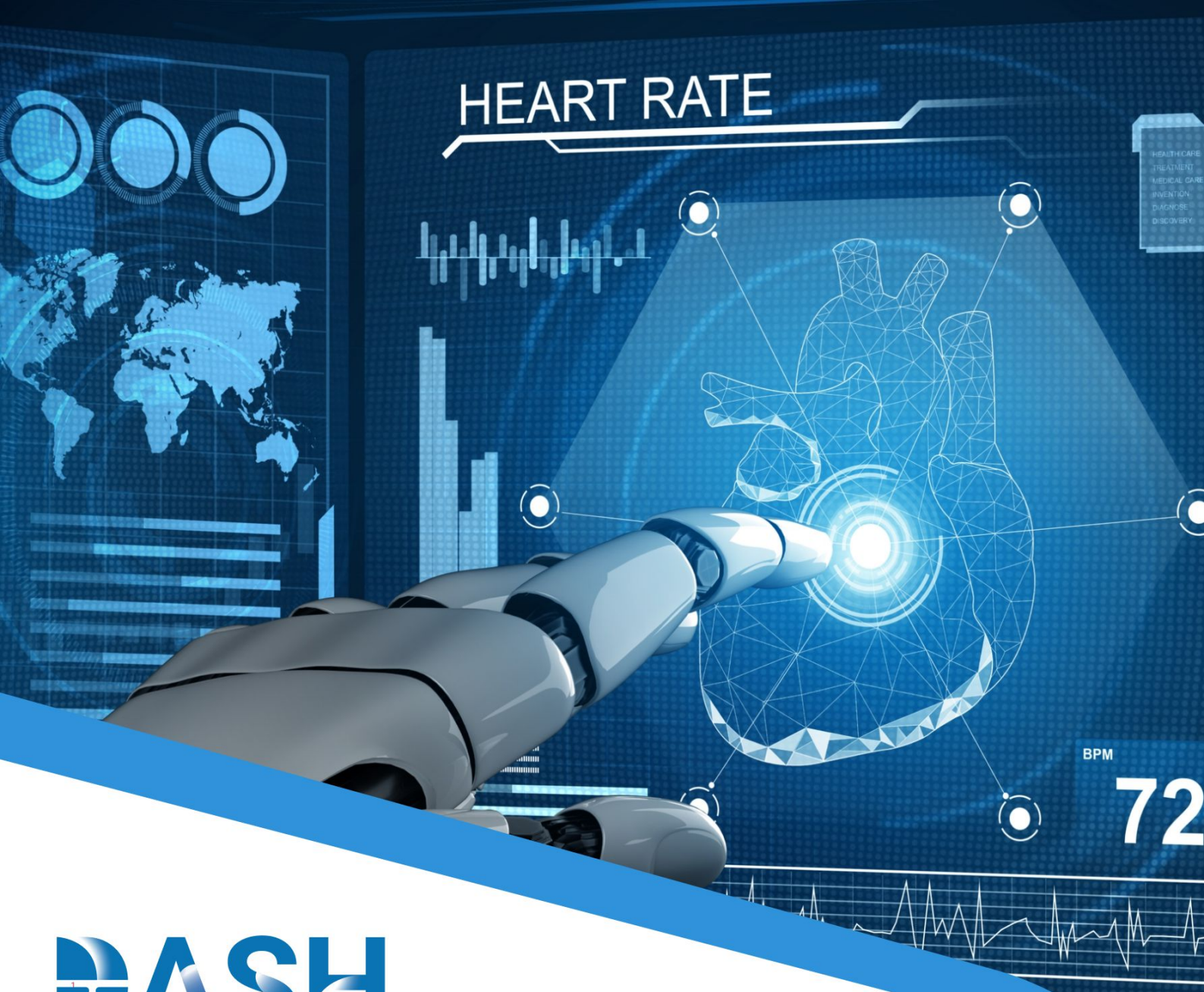


DASH
TECHNOLOGIES

# Top Hospital Board Investment for 2021:

## Artificial Intelligence-Integrated Operating Rooms

**Dash Healthcare Series: No. 2 of 3.**

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# Index

# AI in Healthcare

Although it is hard to think beyond the current pandemic, distance from it will reveal the most intensive 18-month period of innovation since the second World War. This is especially true in the realm of healthcare. In the post-COVID healthcare world, data gathering systems, applied machine learning, artificial intelligence (AI), and data science will seamlessly blend to become the new normal. Hospitals that do not keep up with this technological leap and fail to integrate AI throughout their systems will ultimately lose standing with insurance companies, suffer damage to their public reputation, and most importantly, provide inferior patient outcomes compared to their competitors.

Therefore, it is essential that the healthcare industry begins to collaborate more with technology companies. This collaboration will allow AI systems to be expertly tailored to the practical demands of healthcare. In the past, technology companies have approached healthcare as an industry that understands and embraces innovation but does not necessarily drive it. By the same token, tech companies approach challenges from a technology-first perspective, before considering the practical application of their work. This paper seeks to highlight the need for technology and healthcare companies to collaborate and realize new solutions for 21st century healthcare.

The upsides to implementing AI are almost unfathomable. When hospitals successfully implement AI, they will garner up to $23 billion in cost savings.[1] This implementation will be made possible by leveraging the incredible amount of healthcare data that already exists. In 2013, the world had 153 exabytes[2] (1 exabyte = 1 billion gigabytes) of health data. For reference, all the words ever spoken by humans could be stored in 5 exabytes. Previous technology has allowed us to store this massive amount of data, but AI makes it actionable. This approach means hospitals can now leverage data to improve systems rather than merely house the data for reference. In fact, actionable data could completely overhaul the healthcare system as it exists today.

Many hospitals are placing significant importance on actionable data by integrating AI across all their operations. For example, Humber River Hospital in Toronto is the world's first all-digital hospital. By adding AI to their operating room, the hospital was able to serve 4,000 additional patients per year, the equivalent of adding 45 new beds.[3] These financial benefits are just the tip of the iceberg. Creating actionable data in real time with AI can lead to tremendous cost-savings.

This paper identifies four primary areas where hospitals and technologies companies can collaborate to reap the immense cost savings benefits of AI integration:

- Waste Reduction
- Optimized Procedural Efficiency
- Improved Diagnosis and Treatment
- Revolutionized Clinical Teamwork

# AI-Powered Waste Reduction

A large part of AI's waste reduction will come from decreased duplication of services and better coordination of care. **Currently 60% of patients repeatedly take the same medical tests and 74% of patients provide the same medical information to different healthcare professionals.** Recent studies suggest that up to one fifth of healthcare cost savings are due to these duplications and uncoordinated care.[4] Every healthcare worker and patient is frustratingly aware of this hurdle to better care. In addition to more efficient services, information about resources and cost savings can be shared with the clinical team in real time to enhance resource allocation and decrease cost savings. It is essential that technology companies coordinate with hospitals as they seek to reduce waste. These practical methods of waste reduction should inform the design of future healthcare systems.

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*[1]Rüdemann, N. et al, Brain Lab.*

*[2]Abigail J. F., et al, Efficiency Improvement in the Operating Room.*

*[3]Reddy S, Fox J, Purohit MP. Artificial Intelligence-Enabled Healthcare Delivery.*

*[4]Rüdemann, N. et al, Brain Lab.*

# AI-Powered Diagnostics and Treatment

There are huge cost savings resulting from improved diagnostics and treatment. Top U.S. hospitals are already employing AI tools to collect patient data and evaluate this data against current pathology models. This produces improved diagnostic algorithms and promises to revolutionize care. For example:

- AI is analyzing biometrics and other medical data for individual patients during procedures. It then incorporates these statistics into tailored treatment plans based on current clinical guidelines.
- AI robots are now assisting in providing treatment by executing surgical procedures and administering medication. [5]
- Computer vision and robotics are making all kinds of medical procedures faster and less expensive.
- For the past few years, hospitals have been using AI computer vision to automate analysis of 3D medical images.
- Computer vision and audio allows for remote monitoring of patients. [6]

AI tools will ultimately provide the best possible medical treatment recommendations using these capabilities and others still in development.

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[5]*Abigail J. F., et al, Efficiency Improvement in the Operating Room.*

[6]*Rüdemann, N. et al, Brain Lab.*

# AI-Powered Clinical Team Dynamics

Team communication is one of the most important aspects of clinical care, leading to significant improvements in turnover time (the interval between patient departure and arrival of the subsequent patient). One study found that AI significantly decreased turnover time from a median of 41 minutes during the baseline period to 32 minutes in the interval period. Additionally, in the same study turn-around time, (the interval between surgical dressing application and the subsequent surgical incision) significantly decreased from a median of 81.5 minutes to 71 minutes.[7] These improvements were made possible because of collaboration between hospitals and technology companies and should serve as a blueprint for future innovations. Technology companies need to know where and how to focus their efforts to optimize real-time processes.

# AI-Powered Procedural Efficiency

Lastly, AI will have a significant role in procedural efficiency: standardizing tasks, collecting, and using actionable data via camera and audio recording, and maintaining effective team communication. Procedural efficiency is of the utmost importance because demand for patient services is increasing while available staffing is decreasing. By 2030, the World Health Organization estimates there will be a personnel shortage of up to 9.9 million physicians, nurses, and midwives.[8] These challenges are coupled with enhanced barriers to expanding physical capacity, including the cost savings to purchase or build new locations, as well as the time it takes to launch these new locations.

Although previous process improvement methods (see list below) have been effective, insights from such processes have traditionally been limited to the speed at which humans can process data on a computer. However, by implementing AI, these realized results can be increased tenfold.

**Previous Process Improvement Methods Enhanced by AI:**

- Lean Six Sigma
- Pareto Analysis
- Fishbone Mapping
- SIPOC (Supplier, Input, Process, Output, Consumer)

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*[7]Tagge EP, et al, Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology.*

*[8]Rüdemann, N. et al, Brain Lab.*

- Input Output Analysis
- Total Quality Management
- Parallel Processing
- METEOR (Metric for Evaluating Task Execution in the Operating Room)
- Non-Value Added Analysis
- Continuous Quality Improvement [9]
- Checklists
- TBABC (Time-Driven Activity-Based Cost Savings) [10]

**Overall, AI has a superior ability to do the following compared to former processes:**

- Evaluate large data sets in real time
- Improve treatment models and customize to populations and individual patients
- Improve clinical team dynamics
- Provide information in a never-before-seen, accessible way
- Significantly decrease resource waste

For these reasons, investors acknowledge AI's increasing role in the healthcare system and have invested accordingly. Healthcare AI has increasingly become an investment favorite. About $1 billion was invested in healthcare AI in recent years and the AI health market is projected to hit $6.6 billion by 2021. This growth is 11 times the size of the market in 2014, according to Accenture.[11] The private infusion of capital will significantly boost both technology companies and the public sector as they integrate AI systems throughout their facilities. For example, the USFDA is actively facilitating the introduction of AI-enabled medical devices into the market today.[12] Collaboration like this is what is needed, and further advancements will allow AI technologies to seamlessly integrate into hospitals by having true interoperability with various Electronic Health Records (EHRs).

Incredible advancements in AI are just around the corner, but it is incumbent upon technology companies and hospitals to drive the process together. The best design, development, and implementation comes from collaboration, and the future of healthcare requires the utmost coordination between the companies that design next generation technologies, and the hospitals that will utilize those technologies daily.

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[9] *Tagge EP, et al, Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology.*

[10] *Abigail J. F., et al, Efficiency Improvement in the Operating Room.*

[11] *Reddy S, Fox J, Purohit MP. Artificial Intelligence-Enabled Healthcare Delivery.*

[12] *Abigail J. F., et al, Efficiency Improvement in the Operating Room.*

# The AI "Must Have" for 2021: AI-Powered Operating Rooms (OR)

Operating Rooms (ORs) are the largest contributors to a hospital's financial success. With the most surgical dollars being spent in the OR, this division is a high-priority target for efficiency efforts for a hospital's Board of Directors. In addition to high-cost savings, the OR brings in a considerable amount of hospital revenues, making it the central figure in a hospital's financial blueprint.

ORs are ripe for inefficiencies due to scheduling problems and normative ad-hoc surgical teams. There is considerable documentation illustrating frustration and dissatisfaction among OR personnel and patients due to OR inefficiencies. These negative feelings are scientifically proven to create poorer clinical outcomes, as well as result in higher cost savings for hospitals.[13] However, these inefficiencies can be addressed through AI implementation. In addition to addressing inefficiencies, AI will be able to decrease patient throughput time during surgery, enhance surgical precision through robotics as well as accessibility to patient data to empower all clinical staff.

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[13] *Tagge EP, et al, Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology.*

# The New OR

To develop optimal AI-powered ORs, in a study clinical, staff were consulted and asked to describe the ideal patient journey supported by an AI-integrated OR. With AI-powered OR rooms, new data is constantly collected in one digital platform to form the patient's digital image, a personalized digital twin.[14] The most important aspects throughout the entire patient journey are outlined below:

- Right from the start, the admission process time is reduced with digitalized and simplified check-in forms. With the integration and synchronization of a patient's history into one source, the information necessary to complete the form is minimal (i.e., past medical history) and time spent on such forms is decreased.

- The digitally structured patient data, together with specific AI & Big Data analyses, takes a large amount of the guesswork out of the pre-planning stages. By overlaying statistical information with the personalized data, customized treatment plans become easily visible. The patient benefits from an individualized treatment approach which minimizes the potential adverse events.

- With the help of digital visualization tools displaying medical imaging data, such as mixed reality, the patients can see their medical data as a more tangible object. The surgeon can then guide the patient through the planned procedure, enhancing the patient's understanding, building trust, and answering outstanding questions or concerns.

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[14] *Rüdemann, N. et al, Brain Lab.*

- In the OR, the procedure can be started "just-in time" with the automatic prefetching of data. All relevant data about the patient, merged as the digital twin, is available during surgery, alongside a real-time view of the procedure and the patient's vital parameters. This enables the entire OR team to anticipate and react quickly in case a complication arises.

- Throughout the entire patient journey, data is collected for documentation in the patient record, which continuously builds and finetunes the patient's digital twin. These data points can be accessed during any future in or outpatient procedure to improve the medical care (i.e., medicines prescribed, treatments suggested, etc.) the patient receives. [15]

# Scheduling Powered By AI

AI has the power to address the high degree of uncertainty in daily surgical programs, and the ever-increasing demand for OR services. Today, AI creates efficient and agile room management systems. AI allows for continuous reevaluation and adjustment in minute-to-minute scheduling which can make the best use of available space at any given time.

In addition to pre-surgery scheduling efficiencies, AI can also reduce throughput time for patients. Studies indicate cutting-suture time can be reduced by an AI-powered OR, which will reduce the time and effort it takes to manually position the patient, set up devices, and synchronize systems.[16] AI-powered ORs also help to simplify supporting processes with standardized data handling (through automated central storing and a fast data transfer, allowing caregivers to spend more time providing excellent care). Furthermore, AI allows for optimized checklists, pre configurations and the full availability of imaging data. [17]

Throughput times are negatively affected by disjointed devices and technologies. Survey results from surgical teams show that a growing number of media disruptions, interfaces, isolated digital solutions, and a higher rate of user errors currently impede the seamless surgical flow.[18] In the OR, surgical teams are facing an increasing complexity of medical devices and software, as well as high administrative demands, while oftentimes being held responsible for surgical postponements and overtimes This is a bureaucratic

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[15]*Rüdemann, N. et al, Brain Lab.*

[16]*Rüdemann, N. et al, Brain Lab.*

[17]*Rüdemann, N. et al, Brain Lab.*

[18]*Tagge EP, et al, Improving operating room efficiency in academic children's hospital using Lean Six Sigma methodology.*

obstacle that can cause a lot of frustration. Poorly coordinated processes and missing data integration triggers inefficiencies and duplication of work for the hospital's employees, especially in double analog and digital data logging. AI not only integrates but also fully automates all patient, personnel, documentation, and equipment-related processes.

# Patient Data Powered by AI

Linking machine learning algorithms to EHRs can help surgical teams retrieve accurate and context-relevant patient information without taking their hands and eyes off the patient. Clinical team members may ask questions verbally to a smart assistant who responds both verbally and visually on a large screen in the OR. Furthermore, surgical imaging cockpits that display instant imaging data and which are operable through touchscreen control, enable situation specific and intelligent support with better ergonomics for surgery. Video routing allows for the surgical field to be projected on multiple displays in the OR so that the entire team can stay on track, reacting quickly when needed, without crowding the surgeon. [19]

In addition to information about the patient, information about resources and cost savings can be shared with the clinical team in real time and immediately post-surgery to enhance resource allocation and decrease cost savings. This is a scientifically proven approach. A study found that educating surgeons about the price of disposable tools resulted in a 10% decrease in disposable cost savings for an average decrease of $500,000 in annual cost savings.[20]

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[19] *Rüdemann, N. et al, Brain Lab.*

[20] *Reddy S, Fox J, Purohit MP. Artificial Intelligence-Enabled Healthcare Delivery.*

# Clinical Teamwork Powered by AI

Human factors are of the utmost important in high stakes, high acuity settings such as the OR. Most surgical teams are established ad hoc and composed of different team members from day to day. Each of these team members have different backgrounds. The team requires coordination between providers with different expertise and skills. Lack of knowledge about one another increases the likelihood of miscommunication and interruption during surgical procedures. Team members must continually switch their focus and attention between the execution of their individual assignments and coordination with the team. There are unlimited opportunities for conflict, misunderstanding or unintentional failures. Team factors and device problems are the most common reasons for the high stress levels that surgeons experience.[21]

**Poor communication styles within teams during operations are proven to elicit in the patient:**

- Higher postoperative pain
- Lower postoperative functionality
- Longer lengths of stay
- Higher occurrence of hospital-related infections
- More complaints and medical errors[22]

[21] *Rüdemann, N. et al, Brain Lab..*

[22] *Tørring, B., Gittell, J.H., Laursen, M. et al. Communication and relationship dynamics in surgical teams in the operating room: an ethnographic study.*

**When developing AI in the OR, technical experts have integrated aspects from helpful communication styles to assist teams during operations and prevent consequences of poor communication. Such features include:**

- Call outs: when an AI announces important info
- Check backs: when AI repeats something to ensure it was heard correctly
- Two challenge rule: when an AI repeats information if initially dismissed
- Checklists for team-timeout with full team visibility[23]

The effectiveness of these features is supported by science today. A study discovered that communication errors are responsible for approximately 4 RSEs per surgery and can be reduced three-fold by using structured digital support for the team time-out before surgery. [24]

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[23]*Wakeman D, Langham MR Jr. Creating a safer operating room: Groups, team dynamics and crew resource management principles.*

[24]*Rüdemann, N. et al, Brain Lab.*

# Surgical Procedures Powered by AI

AI-powered OR systems pave the way for a new era of proficiency supported by enabling instant expert opinions during surgery. This is done by empowering junior physicians to perform more complex surgeries based on precise pre-planned imaging data prepared by a senior physician in advance.[25] AI provides significant benefits in the areas of flexible streaming possibilities and real-time remote consultation to align on tasks and responsibilities and to directly obtain medical expert opinions from outside the operating room.

AI can analyze biometrics and other medical data of individual patients while in surgery and recommend treatment plans based on current clinical guidelines. It can also incorporate actual surgical experiences to inform new, improved techniques and insights.[26] These algorithms can predict surgical and post-discharge complications in individual patients.

AI data collection and analysis, ability to detect and respond to audio visual clues during surgery and skill at performing surgery allows for:

- Creating maintaining and monitoring aseptic surgical techniques
- Anticipating the instruments and supplies needed for procedures
- Ensuring the efficient conduct of the procedure is possible [27]

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[25]*Rüdemann, N. et al, Brain Lab.*

[26]*Reddy S, Fox J, Purohit MP. Artificial Intelligence-Enabled Healthcare Delivery.*

[27]*Wakeman D, Langham MR Jr. Creating a safer operating room: Groups, team dynamics and crew resource management principles.*

# How to Implement AI in Your OR

Although many hospitals are reaping the benefits of AI implementation, there are still some who have not integrated AI successfully. The adoption rate of AI in healthcare has been slower than any other sector, accounting for just 50% growth compared to other industries. This is due to hospital executives being extremely cautious about implementing new technologies. This slow adoption rate has been a trend not just with AI, but with all technologies such as standard computers and Electronic Health Records (EHRs).

**In a study, researchers found that the reason for this slower adoption has to do with concerns hospital executives have with:**

- Realistic deployment timelines
- Inability to accurately calculate return on investment
- Cultural factors
- Teaching new technology to staff
- Fear of losing the human touch in patient care
- Inability to easily integrate new technology with existing medical records[28]

Ultimately, all concerns about AI implementation can be abated by taking a few simple steps to enhance your team as well as relying on a sound third-party vendor.

[28]*Reddy S, Fox J, Purohit MP. Artificial Intelligence-Enabled Healthcare Delivery.*

# How to Prep Your Hospital for AI Implementation in the OR

For your hospital to successfully implement AI, your team must view this technology as an essential and interoperable part of the OR workflow, not just a disparate pie-in-the-sky solution. This technology should not be framed as an external module sold by large software organizations, but as an essential OR workflow tool championed internally. In addition to a sense of internal ownership, it is essential to carefully select a strong leader to take accountability of project rollout. This person should have deep knowledge of OR workflows in practice, not just theory. There needs to be a key understanding of the responsibilities of each team member during an OR procedure and what is needed to complete those responsibilities.

**Thirdly, to champion implementation, the entire OR team and your internal IT team should be fluent in efficient communication styles. This team must:**

- Be highly verbal
- Set aside time for brainstorming and troubleshooting
- Be unafraid of altering workflows to accommodate new technologies
- Have familiarity with 360-degree feedback
- Be organically curious about new ways of doing things
- Utilize sprint methodologies


# How to Pick the Right Partner to Implement AI

Your hospital should work with a vendor who offers custom coding of your AI in the OR. This tailored service ensures seamless interoperability. Such a vendor can offer a blueprint for coding and implementation which fits more systems. However, to capitalize on other technology investments in the OR, it is important that there is customization. An example of this is the future wide-spread implementation of virtual sales reps. It is essential your vendor understands your future investments to build out code in preparation for these.

In addition, your vendor should empower your hospital to be nimble with implementation. This means streamlining internal board reviews and assisting with innovative deployment strategies. It also means aiding in clinical roll out. Vendors should prioritize feedback from all staff, especially nurses. 360-degree feedback on this new combination of technology does not have to come from the doctor down the food chain. Instead, think of deployment as an ecosystem—with each party serving an important role. The doctor knows how to replace the knee, but the team knows it is required in the OR and in this process. The vendor should understand each clinical team member has a valuable role.

**In picking a vendor it is also important to make sure they:**

- Have previously completed AI projects in hospital ORs
- Are a small, elite team of programmers, developers and/or engineers
- Are decentralized with almost every team member touching coding
- Are willing to actively participate in your OR process and implementation
- Eager to understand how AI will be used uniquely in your OR
- Place importance on building rapport with clinical staff in the OR
- Have a "project first" mentality
- Are fluent in agile development and methodologies
- Understand sprint project management
- Create realistic deployment timelines
- Create deployment plans which enhance the current cultural landscape within the hospital
- Clearly explain the new technology to staff with various expertise and backgrounds
- Use their technology to enhance "the human touch"
- Set up the technology for ultimate interoperability
- Meet once a week
- Develop operational key metrics (turn-over time and turn-around time)
- Help delegate responsibilities
- Understand each clinical team member's incentives for implementation

# Endnotes


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